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THE EFFECT OF A NEW HIP OA BRACE ON THE SIT-TO-STAND MANEUVER

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Purpose: Asymmetric limb loading during sit-to-stand is employed by patients to avoid weight bearing through their painful limb. Chair rise functional performance is impaired and in the long-term overuse of the healthy side might lead to osteoarthritis of the unaffected joints. A new hip bracing concept for hip osteoarthritis (OA) has been designed to alleviate pain and improve function using the forces of a compressive pelvis belt and a stretched elastic strap around the OA thigh. The present study aims to test whether the brace immediately improves the symmetrical leg loading while rising up from a stool and to examine its effects on upper body kinematics.
Methods: A sit-to-stand movement was performed three times by fourteen subjects with unilateral symptomatic hip osteoarthritis. The loading symmetry ratio (LSR) was measured to quantify the asymmetric limb loading during sit-to stand. LSR was defined as the maximal peak vertical ground reaction force (zGRF) in the OA leg divided by the maximal peak zGRF in the contralateral unaffected leg. A ratio smaller than 1 indicated an overload of the unaffected leg compared to the OA leg; load shift toward the unaffected leg was defined by the equation 1-LSR and expressed as a percentage of body weight (BW). Pain, trunk flexion, trunk flexion velocity and internal hip extension moments were used to compare each patient' differences in chair rise performance between the braced and the unbraced (control), randomly assigned, conditions.
Results: There was no significant difference in the loading symmetry ratio without and with the brace (0.79 ± 0.19 [0.68; 0.89] vs. 0.80 ± 0.14 [0.72; 0.88]). A ratio of 0.80 means that overall 20%BW on average was still shifted toward the unaffected leg in the braced condition. A more upright position was observed just after lift-off with a significant reduction of the peak trunk flexion angle ($p = 0.014$) and trunk flexion velocity ($p = 0.037$). The increase in internal OA hip extension moment while rising up was not significant ($p > 0.05$). However the increase was significantly correlated with pain reduction ($r = -0.79$, $p<0.001$). There was a non-significant decrease in peak internal sound hip extension moment.
Conclusions: Loading symmetry ratio was not shown to be immediately affected by the brace in this short term study. Nevertheless the reduction in trunk flexion angle and velocity along with the changes in extension moment would appear to indicate improved control over the sit-to-stand maneuver. It is unknown if an increase in hip extension moment leads to a reduction in pain or vice versa. However one could speculate that small changes in the position of the femoral head within the acetabulum, caused by the device, alter the femoroacetabular weight bearing area decreasing pain and allowing greater recruitment of the hip extensors. It is also possible that the pelvic belt limits trunk flexion, reducing the forward momentum of the trunk thus necessitating a greater hip extension moment. If these changes were to persist in the long run, loading symmetry may be positively affected.

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SUBJECTS WITH SEVERE KNEE OSTEOARTHRITIS REDUCE MEDIO-LATERAL FORCES DURING GAIT AT THE EXPENSE OF COMPRESSIVE KNEE CONTACT FORCES

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Purpose: Aberrant knee joint loading has been identified as a potential factor affecting onset and progression of knee OA based on the external knee adduction moment (KAM). This study estimates the knee joint reaction forces (KCF) during gait in healthy adults and subjects with increasing severity of knee osteoarthritis (OA) using subject-specific musculoskeletal simulations generated by OpenSim. KCF reflect the combined effect of intersegmental and musculotendon forces and are therefore potentially more representative for knee loading than KAM, a commonly used estimation of internal knee contact forces. We hypothesize that in subjects with increasing levels of OA involvement, the KCF are significantly altered due to the combined effect of aberrant movement dynamics, muscle coordination and joint geometry.
Methods: Thirty-five patients (women, mean age of 69.3) were recruited and separated into three groups: asymptomatic subjects with a Kellgren/Lawrence (K/L) grade of 0 ($n = 11$), subjects with early symptomatic knee OA having K/L grades of 1 or 1+ ($n = 14$) and subjects with established knee OA with a minimum grade of 2+ ($n = 10$).
Gait analysis consisted of level walking along a 10 m walkway at self selected speed. An active 3D motion analysis system (Krypton, Metris) recorded the 3D position of reflective markers attached to the subjects according to an extended Helen Hayes protocol, at 100 Hz. A force plate (Bertec Corporation, Ohio, USA), embedded in the middle of the walkway, measured ground reaction forces and moments sampled at 1000 Hz.
OpenSim (Delp,et al. 2007) was used to generate 3D, subject-specific simulations. The 3D model consisted of 24 degree-of-freedom (DOF) with the tibio-femoral joint modeled as a 2 DOF joint allowing flexion/extension and adduction/abduction, and 86 muscles. After scaling the model, an inverse kinematics was performed. A static optimization routine calculated the muscle force distribution and the resulting knee joint contact forces were calculated for the stance phase. KCF were normalized to body weight (BW). A one-way analysis of variance (ANOVA) with Tukey post hoc test evaluated if differences in the first and second KCF peaks were statistically significant between the 3 groups ($p \leq 0.05$).
Results: The three groups present differences in first and second peak total KCF. Although increased first peak loading was found in more established OA, this was not significantly different between the 3 groups (Table 1). Significant differences ($p = 0.04$) in the second peak KCF were confirmed between early and established OA subjects: for the established OA group, total KCF remained elevated throughout mid stance and the second peak was less pronounced (Figure 1).
Similar changes reflected in the proximo-distal component of the KCF, confirming a significantly increased second peak between in subjects with established OA compared to control subjects ($p = 0.03$) (Figure 2). In contrast, first peak of the medial-lateral component of KCF was elevated more in early OA patients, although not significant. Anterior-posterior components were similar for all groups throughout the stance phase.
Conclusions: We confirm excessive knee joint loading in subjects with established levels of OA involvement while subjects with early OA had similar KCF comparing to the control subjects. Interestingly, early OA subjects presented higher medio-lateral loading compared to established OA subjects, whereas the vertical loading was higher in established OA patients. Further research is needed to evaluate if these changes reflect a protective gait strategy adopted by established OA patients to minimize shear forces in the knee joint during gait.

Table 1
Peak total KCF normalized to BW. (*) Indication of significant differences between groups

	PEAK 1 (mean ± SD)	PEAK 2 (mean ± SD)
Control	3.93 ± 0.63	3.61 ± 0.70
Early	4.06 ± 1.20	3.28* ± 0.66
Established	4.30 ± 0.90	3.72* ± 0.73

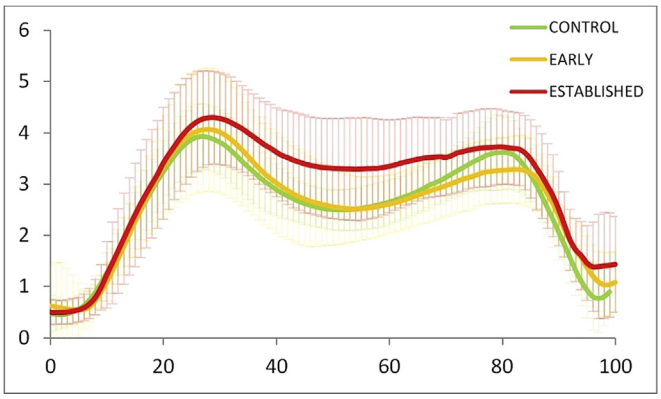

Figure 1. – Average KCF (normalized to BW) during stance phase across varying OA severities.

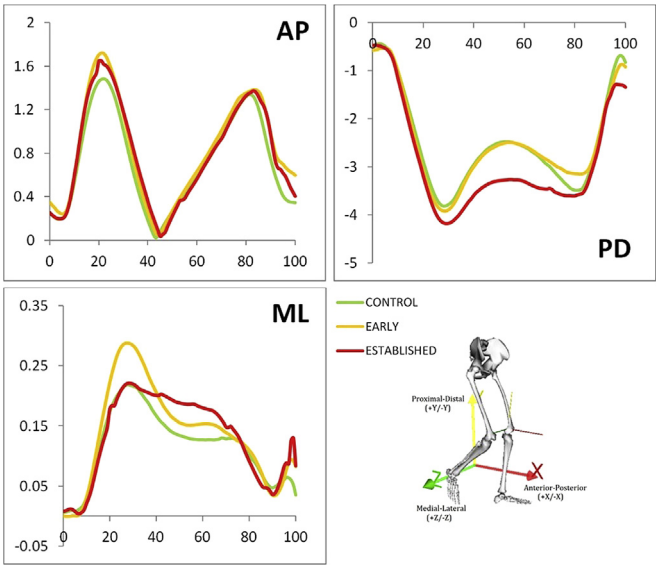

Figure 2. – KCF components during stance phase across varying OA severities.

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INSIGHT FROM DIRECT IN VIVO MEASUREMENTS ON THE FORCE DISTRIBUTION ACROSS THE HUMAN KNEE IN FLEXION: CAN IT BE MODIFIED, AND CAN THE INTERNAL LOADS BE PREDICTED FROM EXTERNAL MEASUREMENTS?

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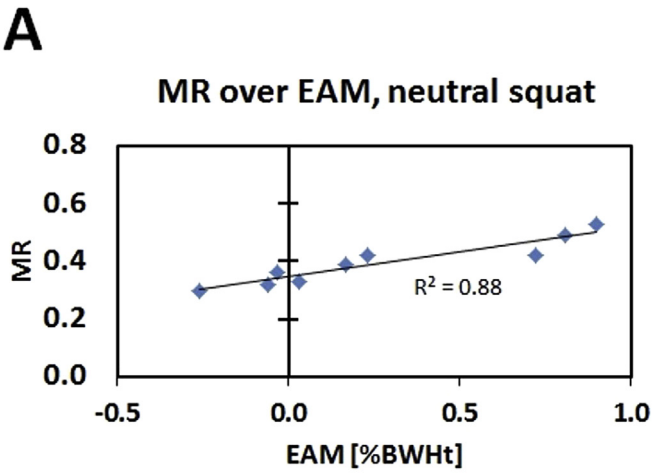
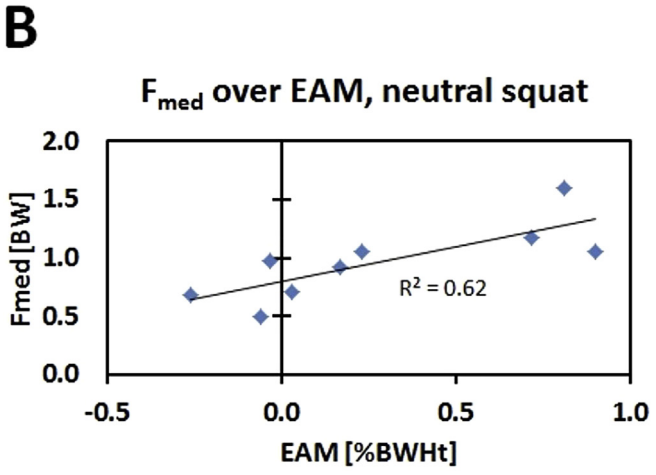
Purpose: An understanding of the medio-lateral distribution of the tibiofemoral (TF) contact forces and the factors influencing this distribution is essential for the targeted development and evaluation of interventions aiming to influence the progression of osteoarthritis. Mechanical models of the human knee have provided a basic understanding of the load distribution at the joint, suggesting a strong correlation between frontal plane alignment and medial loading during walking, when the knee is loaded in a rather extended position. The results obtained here are, however, sensitive to the many assumptions necessary to establish the models, and it remains unclear whether those relationships still hold when the knee is loaded in flexion. Goal of this study was to quantify the medio-lateral force distribution in deep knee flexion using direct measurements of the in vivo knee loading conditions and to examine whether and if so by how much the load distribution can be changed in flexion. In addition, we aimed to assess whether more readily available measures such as the dynamic external knee adduction moment (EAM) or static frontal plane alignment were able to predict the internal loading conditions in deep knee flexion.
Methods: Gait analysis was performed on 9 total knee replacement (TKR) patients with a post-op mechanical axis angle (MAA) ranging from 4.5° valgus to 7° varus. Telemetric implants provided access to the in vivo TF contact forces and the ratio of the medial to total contact force (MR), while kinematics and external knee moments were determined using inverse dynamics analyses based on synchronously collected ground reactions forces and skin marker data for variants of squatting. While maintaining the reference position of their feet established for the neutral squat (approximately shoulder-width apart, 9 subjects), additional data from 6 of these subjects was available where they were asked to squeeze their knees together (valgus squat) or push their knees apart (varus squat). To assess whether knee loading can be modified in deep flexion, the medial contact force (Fmed) and the MR were compared between varus and valgus squats, while linear regression analyses assessed the relation between the external adduction moment (EAM) and either Fmed or the MR and whether the MAA explained any variance in the internal forces. All subjects provided written informed consent to participate in the procedures and the study was approved by the local ethics committee.
Results: The mean MR for the valgus squats (0.33 ± 0.09) was lower ($p<0.05$) than for the varus squats (0.47 ± 0.06), but there was no significant difference in Fmed (0.84 ± 0.:31BW vs. 1.08 ± 0.:19BW, $p > 0.05$). During the neutral squats the patients reached a similar mean peak knee flexion of 95.6°, while the mean MR and Fmed were 0.40 ± 08 and 0.96 ± 0.:32BW, respectively. Linear regression analysis across the 9 subjects revealed a stronger association between EAM and MR ($R2 = 0.88$) than between EAM and Fmed ($R2 = 0.62$) (Figure 1).





There was no substantial relationship between either MR or Fmed with the EAM ($R2 = 0.01$ and 0.21 respectively).
Conclusions: This study revealed that the MR but not Fmed was substantially modified in deep flexion, a condition under which static frontal plane alignment did not explain any substantial variation in either measure of internal knee loading. Here, the EAM derived from inverse dynamics analysis was a better predictor of the MR than Fmed directly measured in 9 subjects, corroborating the notion that the EAM is a proxy for the medial-to-lateral force distribution rather than for Fmed. Clarification of whether changes in kinematics, muscle activation patterns or their combination can explain the changes in MR between varus and valgus squats could help to better understand key mechanisms that enable modification of knee loading and its control.

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POSTURAL STABILITY AND PAIN IN OBESE LADIES WITH MILD KNEE OSTEOARTHRITIS AFTER INTRA-ARTICULAR HYALGAN INJECTION

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Purpose: Knee osteoarthritis is a common cause of disability which influences the quality of life. It is associated with pain and impaired knee joint proprioception which effects postural stability. Postural stability is critical for mobility and physical activities. Current